United States General Accounting Office

GAO

Report to the Honorable
Lloyd Bentsen, U.S. Senate

September 1991

INTERNATIONAL TRADE

U.S. Business Access to Certain Foreign State-of-the-Art Technology

GAO/NSIAD-91-278

GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-244718

September 12, 1991

The Honorable Lloyd Bentsen
United States Senate

Dear Senator Bentsen:

As you requested, we are providing information on whether U.S. firms in the semiconductor, semiconductor materials and equipment, and computer industries have been denied advanced parts, equipment, or technologies from foreign suppliers. We also examined whether U.S. firms were adversely affected by any difficulties they may have experienced in obtaining foreign parts and equipment.

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to the Secretaries of State, Commerce, and Defense; the U.S. Trade Representative; and other interested parties. Copies will also be made available to others on request.

Please contact me at (202) 275-4812 if you or your staff have any questions concerning this report. The major contributors to this report are listed in appendix II.

Sincerely yours,

Allan I. Mendelowitz, Director
International Trade, Energy,
and Finance Issues

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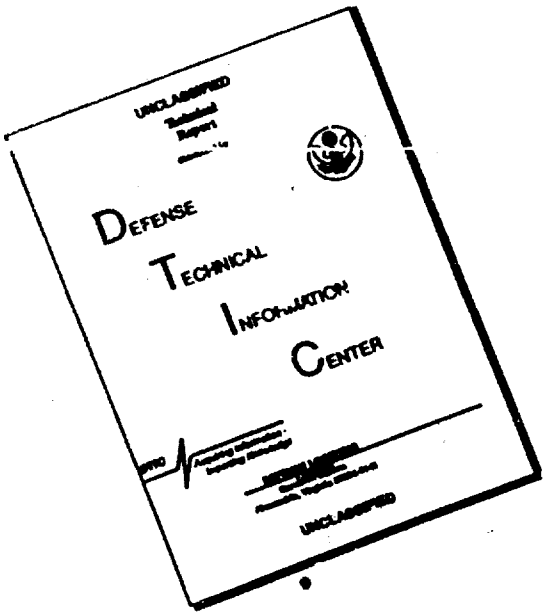

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Executive Summary

Purpose

As foreign firms have become dominant in some high-technology industries, U.S. firms have become increasingly dependent on foreign suppliers for certain state-of-the-art parts, equipment, and technologies. U.S. dependency on foreign suppliers is a critical issue in the debate on U.S. economic competitiveness.

At the request of Senator Lloyd Bentsen, GAO developed information on whether U.S. firms in the semiconductor, semiconductor materials and equipment, and computer industries were being denied advanced parts, equipment, or technologies from foreign suppliers. Specifically, GAO obtained information on (1) whether foreign suppliers have delayed selling or declined to sell state-of-the-art products to U.S. firms when they are being sold to competitors in the country of production, and whether U.S. firms have been adversely affected; (2) the reasons for any difficulties faced by U.S. firms in acquiring foreign, state-of-the-art products; and (3) whether foreign suppliers have pressured U.S. companies to take certain actions—such as buying other items—in order to obtain products.

This report presents the views of various parties involved in the international trading of state-of-the-art technology. GAO could not verify much of the information provided. The U.S. companies interviewed requested that GAO not discuss their specific problems with other U.S. firms or with foreign suppliers. Also, U.S. companies were not required to provide GAO with documented information. Moreover, GAO did not assess whether the practices of foreign suppliers were common business practices or whether they would violate any laws or international agreements.

Background

U.S. companies have begun to rely to a great extent on foreign-produced state-of-the-art parts, equipment, and technologies. Several items related to the production of semiconductors and computers, for example, are available only in Japan. Some of the highest performance semiconductor components needed for supercomputers are no longer manufactured in the United States and must be imported from Japan. Similarly, display screens needed for laptop computers are not produced in sufficient quantity in the United States.

Results in Brief

GAO interviewed 59 U.S. companies in the semiconductor, semiconductor materials and equipment, and computer industries as well as two government research laboratories that buy semiconductors and semiconductor equipment. The U.S. high-tech companies GAO contacted that cited problems in obtaining advanced technologies had problems only with Japanese suppliers. According to U.S. company officials, suppliers from other foreign countries are not sufficiently advanced in the semiconductor and computer industries to withhold technologies.

Fifty-two of those interviewed, or 85 percent, were purchasing state-of-the-art products from Japanese suppliers. About half the firms either said they did not have any problems or could not provide specific examples. Twenty-two, or about 42 percent, provided specific examples of instances in which Japanese suppliers had rejected their offers to buy advanced equipment, parts, or technologies or had delayed their delivery by more than 6 months. Most of the examples provided by the 22 firms occurred between 1988 and early 1991. According to the U.S. firms, these suppliers were not limiting those products to in-house use but were selling them to other Japanese firms. The U.S. companies are concerned that because of the rapid advancement of technology, even a brief delay in obtaining a part or piece of equipment can cause a company to fall a generation behind in its technological capabilities, resulting in lost market share.

U.S. company representatives told GAO that Japanese suppliers often cited reasons for delaying or denying sales, such as a lack of U.S. service facilities and the need for product testing. The U.S. industry representatives who asserted that Japanese suppliers withhold certain products from U.S. firms generally did not believe this practice was illegal.

GAO interviewed six major Japanese suppliers that were among those cited for delaying or refusing sales to U.S. firms. All of these companies stated that they had not declined sales of state-of-the-art products to U.S. firms. Most of these companies asserted that the need for servicing and testing new products would not prevent or delay sales of these products to the United States.

The U.S. companies GAO interviewed indicated that pressure by Japanese suppliers on U.S. companies to take certain actions—such as buying other items—in order to obtain products is not a significant problem. Only seven, or 12 percent, of the 61 U.S. companies and government laboratories GAO interviewed cited specific instances in which they were pressured by Japanese suppliers.

Principal Findings

Some U.S. Firms Have Had Difficulty Obtaining Japanese Products

Twenty-two of the 52 U.S. companies and government laboratories GAO contacted that were interested in purchasing foreign state-of-the-art products said they had difficulty getting advanced equipment or parts from Japanese suppliers. Seven companies, including 3 of the 22, said they had experienced pressure from Japanese suppliers to take certain actions in order to obtain products. Seven other companies said they had experienced some difficulty, but could not provide specifics. Nineteen companies, or about 36 percent, said they had no problems purchasing Japanese state-of-the-art products.

The 22 companies that cited difficulty with Japanese suppliers provided 59 specific instances in which Japanese firms delayed selling or declined to sell them state-of-the-art equipment or parts that were being sold to other Japanese firms. About half of the U.S. companies were large firms. Although most of these companies did not provide documentation to support these examples, they gave detailed descriptions of their attempts to purchase specific items. The items most frequently mentioned as being difficult to obtain from Japanese suppliers included semiconductor manufacturing equipment, semiconductor assembly and packaging materials, and computer components. U.S. firms reported lags of between 6 months and 2 years in obtaining these products. They maintained that, in many cases, by the time they had obtained the item they were seeking, the supplier had already introduced the next-generation product. Frequently, there were no alternative suppliers.

Many U.S. companies stated that their inability to obtain Japanese state-of-the-art products is of critical importance because of the adverse impact it has had on their competitiveness. Three companies estimated lost sales that ranged from $20 million to $1.4 billion because they were unable to purchase Japanese parts or equipment. Three other companies stated that they were unable to manufacture certain products. Two companies maintained that they had introduced new products about 1 year after their Japanese competitors.

The U.S. industry representatives who said that Japanese suppliers do hold back certain products from U.S. firms generally did not believe this practice was illegal and did not advocate imposing punitive measures against Japanese suppliers. In their view, a stronger U.S. technology

base and reduced U.S. dependence on Japan for critical technologies and equipment are needed.

Japanese Suppliers Deny Withholding Products From U.S. Firms

The six Japanese firms GAO interviewed in the semiconductor, semiconductor materials and equipment, and computer industries stated that they do not favor Japanese firms over U.S. and other foreign firms in selling their state-of-the-art products. Five of the six firms denied that the need to service and test new products would cause them to refuse or delay sales to U.S. firms. A few Japanese companies said that other factors, such as supply shortages and tailoring products to meet the customer's specifications, may cause delays in delivering state-of-the-art products to U.S. firms.

According to many of the U.S. companies that GAO interviewed, some factors do enhance the potential of a U.S. firm to purchase large quantities of leading edge Japanese products. These factors include the ability of a U.S. firm to purchase large quantities of products and the presence of U.S. company facilities in Japan.

Most Companies Did Not Experience Pressure From Japanese Suppliers

Only 7 of the 61 U.S. companies and government research laboratories that GAO interviewed said they were pressured by Japanese suppliers to buy other items or license technologies in order to obtain key semiconductor components. Most of these instances involved companies' efforts to obtain memory chips from Japanese suppliers in 1987 and 1988 when there was a shortage of these components, the majority of which were produced in Japan. U.S. firms stated that during this period they were also pressured by U.S. suppliers to buy other items in order to obtain memory chips. They noted that such business practices are not uncommon.

Recommendations

This report contains no recommendations.

Agency Comments

As requested, GAO did not obtain written agency comments on this report. To assure the accuracy of the information provided, GAO did obtain concurrence from appropriate U.S. companies on the presentation of specific examples described in this report.

Contents

Appendixes

Glossary

Tables

Figures

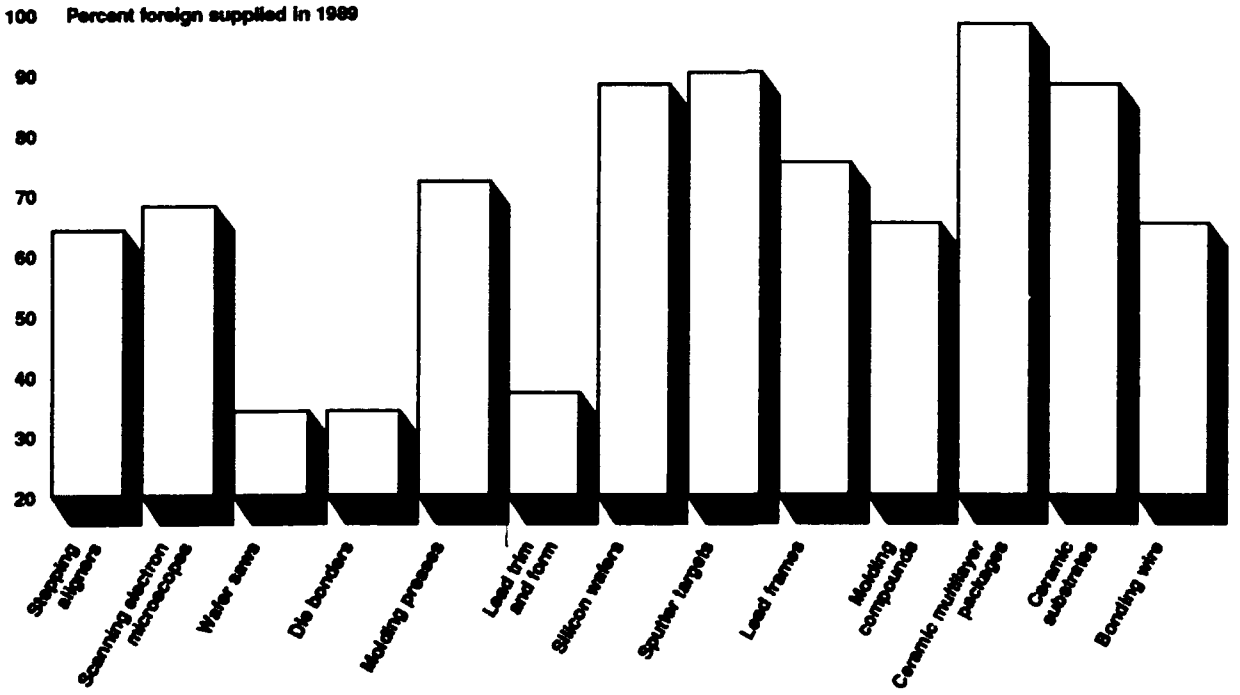
Abbreviations

ASIC	application specific integrated circuits
DRAM	dynamic random access memory chips
GAO	General Accounting Office
MITI	Ministry of International Trade and Industry (Japan)
SEMATECH	SEmiconductor MAnufacturing TECHnology
SM&E	semiconductor materials and equipment

Introduction

In the post-World War II period the United States was generally acknowledged as the world leader in advanced technologies. In recent years, however, U.S. dependence on foreign suppliers for state-of-the-art technologies, parts, and equipment has increased as foreign companies have become dominant in certain high-tech industries, such as semiconductors and semiconductor materials and manufacturing equipment (see fig. 1.1). Several items critical to these industries, such as high-performance semiconductor devices and certain types of materials used in semiconductor production, such as ceramic packaging, are manufactured almost solely by foreign companies. Although the United States still holds a commanding lead in the computer industry, its share of world computer sales has declined in recent years. More importantly, U.S. computer companies have become increasingly dependent on foreign suppliers for such critical components as high-performance semiconductor chips and flat-panel displays. (See glossary for definitions of semiconductors, semiconductor equipment, and computer terminology.)

Figure 1.1: U.S. Dependence on Critical Foreign Semiconductor Equipment and Materials, 1989



Source: VLSI Research, Inc

Japan is the U.S.' principal competitor in the semiconductor, semiconductor materials and equipment, and computer industries. It is the largest producer of semiconductors in the world and the dominant supplier of many state-of-the-art semiconductor materials and manufacturing equipment. Japanese companies are also the only producers of several items necessary for manufacturing the most advanced computers.

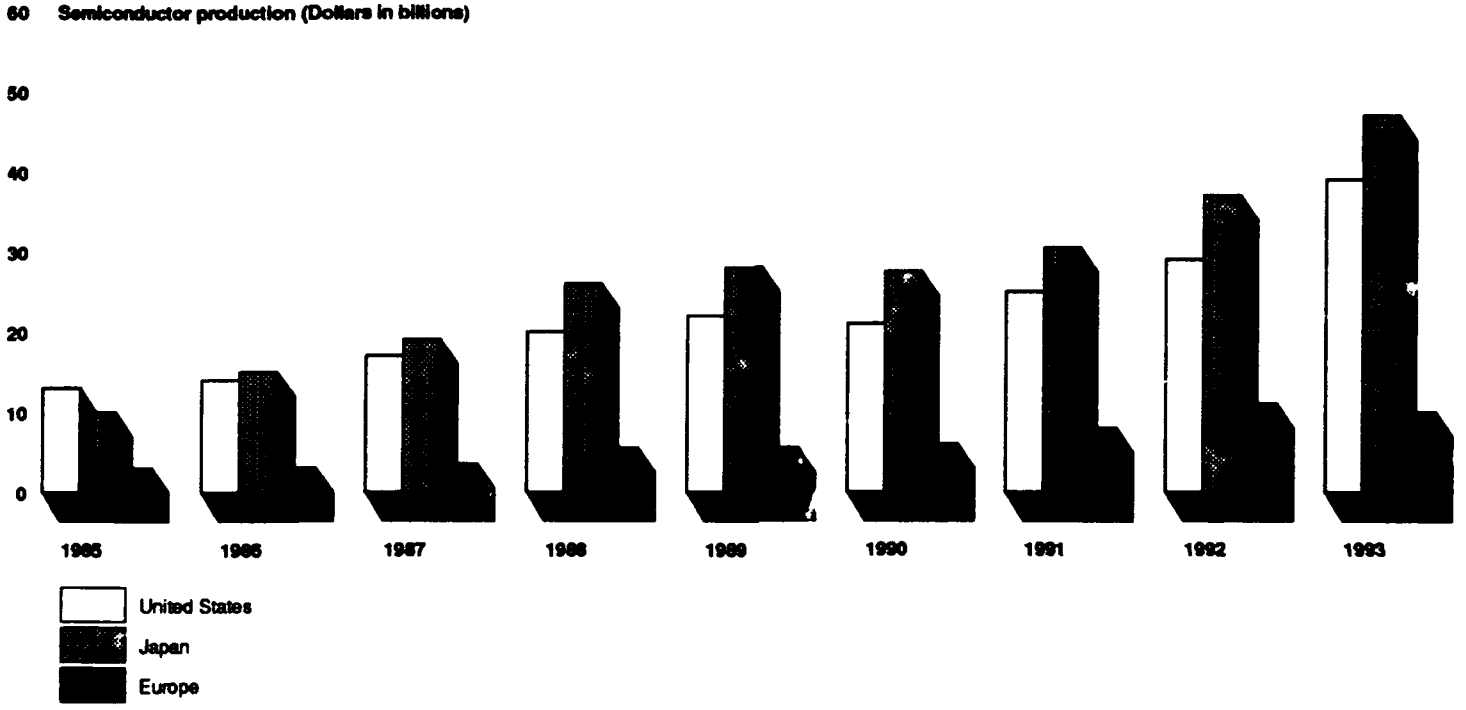
Decline of the U.S. Semiconductor Industry

Semiconductors—devices that enable computers and other products to process and store information—are the foundation of the electronics industry, which had worldwide sales of about $550 billion in 1989. The ability to produce advanced semiconductors is critical to the production of advanced computers, telecommunications equipment, defense weapons systems, and other sophisticated electronic products.

Until the early 1980s the United States was the world leader in semiconductor production. U.S. companies have since lost a significant portion of their market share in the production of semiconductors, particularly memory chips, to Japanese companies. From 1980 to 1989 the U.S. worldwide semiconductor market share declined from 57 to 35 percent, while Japan's share increased from 27 to 52 percent.[1] Although U.S. semiconductor production steadily increased in the late 1980s, the United States is continuing to lose worldwide market share in semiconductors at about 2 percentage points per year. (See fig. 1.2.) In 1990 Japanese companies exported $3.2 billion in semiconductors to the United States, while the United States exported $966 million in semiconductors to Japan.

[1]Throughout this report, market share statistics on the U.S. and Japanese semiconductor and semiconductor materials and equipment industries refers to production by U.S. and Japanese-owned companies irrespective of the location of the production.

Figure 1.2: World Semiconductor Production, 1985-1993



Note: 1991-1993 are estimates.
Source: Dataquest Incorporated

Japanese firms have 90 percent of world market sales of dynamic random access memory chips (DRAM), which are the most widely used chips in computers and other digital equipment. From 1975 to 1986 the U.S. share of open market sales of DRAMs declined from nearly 100 percent to less than 5 percent, with Japanese companies gaining most of the U.S. market share. South Korea has also made significant strides in DRAM production, and the European Community has increased its semiconductor production as well.

U.S. companies are still strong in producing several important specialized semiconductor devices. The United States remains the leader in microprocessors, which are more complex and specialized than memory chips and perform many sophisticated functions, such as sorting data and performing calculations. However, Japan is making a concerted effort to catch up in this area. Although U.S. companies hold more than half of the microprocessor market, some estimates put Japan's share at 40 percent or more. In addition, the demand for microprocessors is

expected to continue to rise in Japan. Similarly, although U.S. companies are strong leaders in application specific integrated circuits (ASIC) or customized chips, the Japanese are strong contenders, with 40 percent of the world market.

Japan's dominance in semiconductor production is partly due to the structure of its semiconductor industry. While Japanese industry is vertically integrated, the U.S. industry is divided among captive companies (ones that produce chips exclusively for their company's internal use and do not sell on the open market) and merchant companies that sell their chips on the open market. U.S. merchant semiconductor manufacturers produce approximately 75 percent of U.S. semiconductors. Most of these companies are small and depend solely on semiconductor sales for their revenues. They compete against large Japanese firms that produce not only the semiconductor chips used in computers but the computers themselves, as well as many other electronics products. These Japanese firms sell semiconductors on the open market as well as use them for in-house production. Six Japanese firms, all vertically integrated, produce 85 percent of all Japanese semiconductors.

The Japanese domestic chip market is now larger than the U.S. market, giving Japanese firms another advantage over U.S. companies. In 1990 the Japanese market consumed $22.6 billion in semiconductors, while the United States, Canada, and Mexico together consumed only $17.4 billion. In the same year the European market consumed $10.7 billion.

U.S. Companies Are Losing Ground in the Semiconductor Materials and Equipment Industry

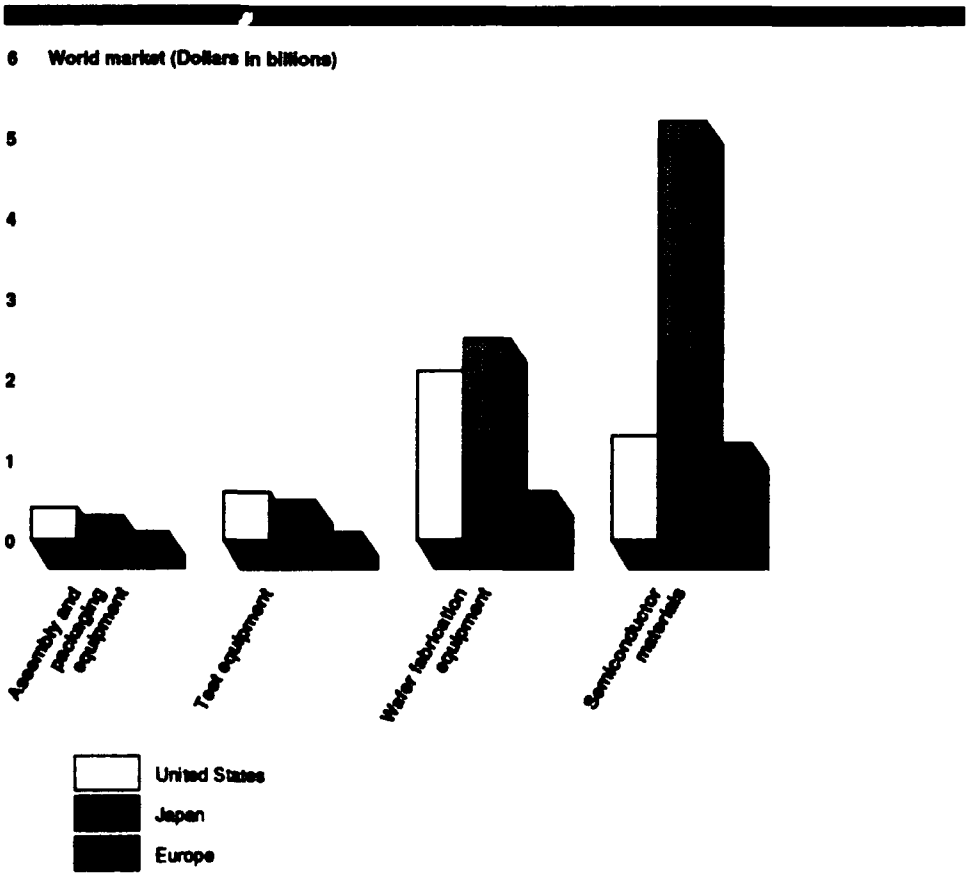
Because the semiconductor materials and equipment (SM&E) industry supplies the capability to manufacture semiconductors efficiently, it is an essential part of the infrastructure supporting the semiconductor and electronics industries. Several recent studies have highlighted the critical interrelationships among semiconductor manufacturers, suppliers of semiconductor materials and equipment, and computer manufacturers. These studies raise concerns that the erosion of the U.S. semiconductor equipment and materials supplier base in turn reduces the competitiveness of the U.S. semiconductor industry and places U.S. electronics manufacturers at a competitive disadvantage.

Although U.S. producers retain a significant share of the overall world SM&E market, their portion is declining. Moreover, U.S. firms have lost market share dramatically in several critical market segments. These market segments include advanced lithography equipment and materials

such as silicon, the basic material used to make the majority of semiconductor wafers.

The U.S. share of the semiconductor equipment market has declined from 69 percent in 1983 to 51 percent in 1988 and is projected to fall to 36 percent by 1993. By contrast, Japanese companies' market share increased from 25 percent in 1983 to about 40 percent in 1988. The portion of the U.S. semiconductor equipment market served by U.S. wafer fabrication, assembly, and test equipment producers declined from 87 to 80 percent between 1983 and 1988 and is projected to fall to 70 percent by the end of 1993. The share of Japanese semiconductor equipment producers' sales in the U.S. market is increasing at a rate equal to the loss of the U.S. equipment manufacturers' sales (see fig. 1.3).

Figure 1.3: Worldwide Market Share for Semiconductor Equipment and Materials, 1988



Sources: VLSI Research, Inc., and Rose Associates

Other statistics also show the decline in the U.S. SM&E industry. In 1980, 9 of the top 10 semiconductor equipment manufacturers were U.S.-owned companies. In 1990 only 5 of the 10 were U.S.-owned and 5 of the top 6 were Japanese-owned. While some U.S. semiconductor suppliers are large companies, 88 percent of the 850 U.S. SM&E companies had annual sales of less than $25 million in 1988. Most of these companies produce equipment and materials for only a few of the more than 100 steps involved in manufacturing semiconductors. Many Japanese SM&E firms, by contrast, are large vertically integrated firms with annual sales of over $25 billion. Strong ties to local and in-house semiconductor manufacturers allow Japanese equipment makers to have quick access to the latest technology and also give them a stronger influence over the direction of technology development.

The United States is also losing market share in several wafer fabrication equipment market segments. For example, the United States has virtually lost the critical industry segment of lithography equipment, which is used to transfer integrated circuit patterns onto semiconductors. U.S. companies' share of world sales for lithography equipment declined from 71 percent in 1983 to 29 percent in 1988. Similarly, U.S. companies' share of world sales for equipment that implants ions on semiconductor wafers—another important segment—dropped from 77 percent in 1983 to 51 percent in 1988.

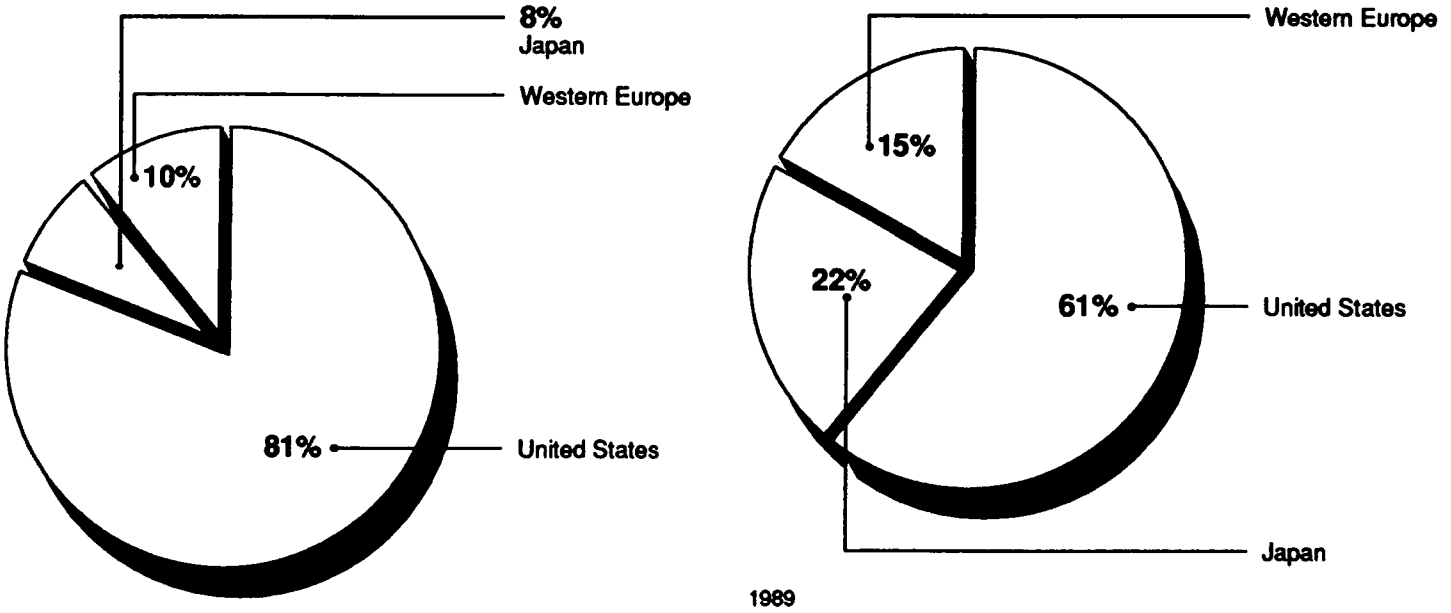
U.S. firms also continue to lose world market share in semiconductor test equipment. In semiconductor assembly equipment, U.S. firms are maintaining their market share in some equipment while losing it in others.

The U.S. share of the world market for assembly/packaging materials is stable at 10 percent. However, the U.S. share of wafer fabrication materials, such as silicon, which is the basic building material of all commercial semiconductors, continues to decline rapidly. Overall, U.S. materials suppliers' market share declined from 25 percent in 1984 to 17 percent in 1988. In the latter year Japanese companies dominated the world packaging materials market, including ceramic packages, which is the material used to package semiconductor chips. One reason for the loss of U.S. market share has been the recent acquisition of several U.S. materials companies by foreign companies, primarily Japanese.

Foreign Competition Is Beginning to Erode the U.S. Lead in Computers

Although the United States still maintains a commanding share of the world computer market, foreign competition has seriously eroded the industry's strong position in the world market and its technological leadership over the past decade. The U.S. share of world computer systems sales declined from 81 percent in 1983 to 61 percent in 1989. During this period, Japan's share grew from 8 to 22 percent and Western Europe's share rose from 10 to 15 percent (see fig. 1.4).

Figure 1.4: World Market Share for Computers, 1983 and 1989



Source: U.S. Department of Commerce.

Japan is the U.S.' main competitor in almost all product segments. While U.S. firms are ahead in microcomputers, workstations, and high performance computer systems, they are losing ground to Japanese firms in displays, storage devices, and laser printers. Because of their expertise in high-volume manufacturing and miniaturization, Japanese firms are taking the lead in portable and laptop computers. Other Asian countries, such as South Korea and Taiwan, are becoming very competitive in microcomputers and peripherals. The European Community may become a significant competitor in parallel processors.

U.S. computer companies are becoming increasingly dependent on their Japanese competitors for critical components such as semiconductors

and flat-panel displays, which will be important for future computers. For example, the highest performance memory and certain logic components useful for supercomputers are no longer manufactured in the United States and are available only from Japanese suppliers. American computer makers now get more than half of their chips from Japanese companies, which are their competitors in the computer market. Six Japanese firms produce 80 percent of Japanese computers, and four of these companies are also the largest semiconductor producers. Display screens needed for laptop computers are produced only in limited quantity in the United States and must be imported from Japan. Most industry experts expect the market for these displays to be controlled by a small number of large, vertically integrated Asian companies.

Items Produced Only in Japan or Produced in Lesser Quantity or Quality in Other Countries

U.S. industry representatives cited several important items related to the production of semiconductors and computers that are only produced in Japan, or are produced in lesser quantity or quality in other countries. Japanese firms, for example, are the only producers of high-speed emitter-coupled logic (ECL) memory chips, which are used in supercomputers. Similarly, electron cyclotron resonance (ECR) etchers—state-of-the-art wafer fabrication equipment—are only produced by Japanese companies. Although one U.S. company still produces wafer steppers, a critical piece of wafer fabrication equipment, many industry analysts believe that the highest quality steppers are now produced in Japan.

Japanese companies are the only producers of several critical semiconductor materials. Ceramic packaging for integrated circuits and advanced molding compounds, both of which are used to encase finished semiconductors, are produced primarily in Japan. Japan also dominates the market for silicon. Although a German firm also produces silicon, its silicon is more expensive and of lower quality than that produced by Japanese firms.

The Japanese are the indisputable leaders in producing liquid crystal displays, which are used in small "notebook" computers and miniature televisions. Active matrix displays, which are the most advanced liquid crystal displays available, are almost exclusively produced by Japanese firms. Although active matrix displays are now used primarily in miniature televisions, most industry experts agree that they will be the display screens used in future computers. Japanese firms are also dominant in other products related to computers, including floppy disks, optical storage disks, and laser printer engines.

Objectives, Scope, and Methodology

At the request of Senator Lloyd Bentsen, we developed information on the extent to which U.S. firms in the semiconductor, semiconductor materials and equipment, and computer industries were being denied advanced parts, equipment, or technologies from foreign suppliers. Our objectives were to obtain information on (1) whether foreign suppliers have declined to sell or have delayed sales of state-of-the-art products to U.S. firms when they are being sold to competitors of U.S. companies in the country of production, and whether U.S. firms have been adversely affected; (2) the reasons for any difficulties faced by U.S. firms in acquiring foreign, state-of-the-art products; and (3) whether foreign suppliers have pressured U.S. companies to take certain actions in order to obtain products.

To explore the extent to which U.S. firms were having difficulty obtaining foreign, state-of-the-art products, we interviewed 59 U.S. companies in the semiconductor, semiconductor materials and equipment, and computer industries and a few telecommunications and electronics companies that buy items from these three industries. We attempted to select a representative sample of companies, including a range of small, medium, and large firms. We interviewed 12 of the 15 largest U.S. semiconductor device companies and 8 of the 10 largest semiconductor equipment firms. We obtained information from 10 of the 11 largest U.S. computer companies. We also met with officials from two government research labs that buy semiconductors and semiconductor materials and equipment. Appendix I lists the types of U.S. companies we interviewed by category.

We met with representatives from some U.S. companies and had telephone interviews with others. We also obtained information from 11 large Japanese company subsidiaries in the United States regarding their ability to service their equipment in the United States.

We obtained information on Japanese sales of state-of-the-art products to U.S. firms from officials in the Departments of Commerce, State, and Defense; the U.S. Trade Representative; the Customs Service; and representatives from the U.S. intelligence community. We also interviewed 14 academics and market analysts with extensive knowledge of these industries. In addition, we interviewed officials from several associations representing the U.S. semiconductor, SM&E, and computer industries. Representatives from a few industry associations declined to be interviewed, referring us to individual companies. In addition, we reviewed numerous government and industry reports on the semiconductor, SM&E, and computer industries.

In Japan we met with officials from six large Japanese companies in the semiconductor, SM&E, and computer industries. Four of the six firms are large, vertically integrated companies each with annual sales over $14 billion. These companies include the Japanese suppliers cited most frequently by U.S. firms as withholding state-of-the-art equipment and parts. Most of the Japanese companies we interviewed manufacture products in more than one of the three industries. We also obtained information from several U.S. semiconductor, SM&E, and computer company subsidiaries in Japan.

In Japan we also met with representatives from the Ministry of International Trade and Industry (MITI), the Ministry of Foreign Affairs, and three semiconductor and electronic industry associations.

Some of the information provided to us by U.S. and Japanese firms was proprietary business information. For that reason, Senator Bentsen authorized us to assure companies that individual responses would be treated as business confidential. All the U.S. and Japanese companies we interviewed requested that the specific details of our discussions be treated as business confidential and that their company names not be used in our report. In discussing any specific examples of difficulties with Japanese suppliers, U.S. companies requested that we not include detailed information that could cause their company to be identified.

Because U.S. companies we interviewed requested that we not discuss their specific problems with other U.S. firms or with Japanese suppliers, and because they were not required to provide us with documented information, we could not verify much of the information provided. However, these companies provided us with detailed information regarding their attempts to purchase items from Japanese suppliers. This information included specific equipment model numbers, the time frames in which they tried to purchase these products, and the circumstances surrounding attempted purchases. In cases in which citing specific items would not disclose the identity of the prospective buyer, we asked Japanese suppliers if there were any restrictions on selling these items to foreign customers in the relevant time period.

Our work was limited to reviewing examples provided by U.S. companies in which they reported that they were denied foreign state-of-the-art products in the semiconductor, semiconductor materials and equipment, and computer industries and the impact that this denial may have had on U.S. firms. We did not compare the practices of foreign suppliers to U.S. business practices. Further, we did not assess whether these

practices would violate any laws or international agreements. Such an assessment would present numerous complexities and was beyond the scope of our work.

We performed our review from September 1990 to July 1991 in accordance with generally accepted government auditing standards.

As requested, we did not obtain written agency comments on this report. To assure the accuracy of the information provided, we did obtain concurrence from appropriate U.S. companies on the presentation of specific examples described in this report.

Some U.S. Firms Cite Difficulty Purchasing Foreign State-of-the-Art Products

The U.S. government and industry association representatives that we contacted generally believed that Japanese suppliers were declining to sell or were delaying sales of certain advanced products to U.S. firms that they were selling to other Japanese companies. In addition, a number of U.S. government and industry studies have pointed out difficulties experienced by U.S. semiconductor and computer firms in obtaining Japanese state-of-the-art products. They raised concerns that if U.S. firms do not gain access to such technology at the same time as their Japanese competitors, they will be at a competitive disadvantage in manufacturing next-generation products.

During our interviews with 61 U.S. high technology firms and government research laboratories, 52 said they were purchasing state-of-the-art parts, equipment, or technologies from foreign suppliers. About 42 percent of these firms and laboratories provided specific examples of (1) where they had been unable to obtain items from foreign suppliers that they said were being sold to their competitors in the country of production or (2) where they had encountered delays of over 6 months in acquiring those items. Another 13 percent said they had experienced difficulties obtaining items from foreign suppliers but did not provide specifics. Nine percent said they had experienced other problems in acquiring foreign products. The remaining 36 percent said they had no problems purchasing advanced foreign products.

Most of the examples of difficulties with foreign suppliers cited by U.S. firms occurred between 1988 and early 1991. All of these examples involved difficulties in purchasing items from Japanese suppliers. According to the U.S. firms and government laboratories, these suppliers were not limiting these products to in-house sales, but were marketing them to other Japanese firms. The items most frequently cited as being difficult to obtain from Japanese suppliers included wafer fabrication equipment and semiconductor assembly and processing materials.

Officials from about half of the U.S. firms that cited instances of Japanese withholding[1] provided specific examples of how their firms had felt adverse effects. The adverse impacts they cited included lost sales, an inability to produce certain products, and delays in introducing new products.

[1] In this report, the term "withholding" is used to describe when suppliers declined to sell products or delayed their delivery by more than 6 months.

Representatives from the majority of the U.S. firms we interviewed, even those that maintained that their firms were subjected to withholding by Japanese suppliers, did not believe that withholding practices were illegal. They did not favor imposing punitive measures against Japanese firms. Rather, they advocated developing a stronger U.S. technology base and reducing U.S. dependence on Japan for critical products and technologies.

U.S. Industry Associations' and U.S. Government Officials' Views

Representatives from all five of the industry associations and market research firms and most of the U.S. government officials we contacted stated that Japanese suppliers of state-of-the-art equipment and parts were supplying their Japanese customers before U.S. and other foreign customers.

Industry Associations

Officials from four of the five industry associations and market research firms provided examples of Japanese products they contended were being sold to Japanese companies but were either not sold to U.S. firms or were sold on a delayed basis. Representatives from these organizations said they were aware of the problems in obtaining state-of-the-art equipment from Japanese suppliers mainly through complaints they have received from U.S. firms. An official from one industry association, for example, stated that since the mid-1980s his organization receives, on average, complaints from 15 U.S. firms each year about their inability to obtain Japanese products that were being sold in Japan. He said his organization has tried to verify these complaints and has found that the majority have been legitimate.

An official from the fifth organization said that although he believes Japanese companies generally supply domestic companies first, he does not view this as a problem for U.S. companies because the differences in the latest generations of equipment "are not always significant."

U.S. Government Officials' Views

Officials from most of the U.S. government agencies we contacted said they believed that Japanese companies were holding back certain advanced products from U.S. firms while selling them to other Japanese firms. The products they mentioned as being denied to U.S. firms included semiconductor manufacturing equipment, advanced display screens, and ceramic packaging for semiconductors. The U.S. officials said they had heard of such situations through complaints they had

received from U.S. companies about difficulties in obtaining Japanese state-of-the-art parts and equipment. Most of the agency officials said they thought withholding by Japanese suppliers was a serious and fairly pervasive problem.

Recent Studies

While there have been no definitive studies on whether Japanese suppliers delay selling or decline to sell state-of-the-art products to U.S. firms, several U.S. government and industry studies have referred to difficulties experienced by U.S. semiconductor and computer firms in obtaining Japanese products.[2] A 1991 report to the Defense Science Board,[3] for example, states the following:

> ...evidence of willingness on the part of U.S. allies to withhold technology from us is increasing, probably in direct relation to the extent of technology leadership...a Japanese firm is known to have withheld the sale of an advanced microelectronics package for supercomputers to a U.S. firm because the sale would have stripped another Japanese computer producer of its competitive advantage.

Semiconductor Manufacturing Technology (SEMATECH), a semiconductor research and development consortium funded by the U.S. government and private industry, issued a report in early 1991[4] on a visit made by SEMATECH representatives to a major semiconductor equipment trade show in Japan in October 1990. In discussing the availability in the United States of state-of-the-art Japanese semiconductor equipment displayed at the show, the report concluded the following:

> There is a six month or longer delay before new tools are introduced into the U.S. This is due to an emphasis on first filling the market needs in Japan and Asia. In a few cases, there were no plans to sell the tool in the U.S....The most key point of the SEMICON Japan show is that a lot of advanced equipment was shown in Japan that is not yet available in the U.S.

The report describes about 100 pieces of new, Japanese state-of-the-art equipment that were displayed at the show. The report identified 21 specific products that Japanese suppliers told SEMATECH officials were

[2]These studies include Foreign Ownership and Control of U.S. Industry, Defense Science Board Task Force (Washington, D.C.: May 1991); Making Things Better: Competing In Manufacturing, U.S. Office of Technology Assessment, (Washington, D.C.: Feb. 1990); and U.S. Supercomputer Vulnerability, Institute of Electrical and Electronics Engineers Scientific Supercomputer Subcommittee of the Committee on Communications and Information Policy (Washington, D.C.: Aug. 8, 1988).

[3]Foreign Ownership and Control of U.S. Industry.

[4]Technology Transfer: SEMICON Japan 1990 Trip Report, SEMATECH (Austin, Tex.: Jan. 29, 1991).

not available in the United States at the time of the show.[5] According to the report, nine of these products would not be sold in the United States for 6 to 18 months; six products might never be available in the United States; and it was unclear if or when six other products would be sold in the United States. According to the report authors, most of these products were being sold in Japan at the time of the show.

A SEMATECH trip attendee estimated that about 75 percent of all the products covered at the show were not being marketed in the United States at the time of the show, whereas about 75 percent were being sold in Japan. As of April 1991 he asserted that the majority of the products covered at the trade show were still not being sold in the United States.

U.S. Firms Cite Problems Only With Japanese Suppliers

None of the U.S. companies or government laboratories that we contacted cited problems in obtaining advanced technologies from any foreign supplier other than the Japanese. Although the South Korean, Taiwanese, and European semiconductor and computer industries are growing and their companies are becoming increasingly technologically advanced, they are generally still behind those in Japan as well as the United States. According to U.S. government and private sector officials, suppliers from foreign countries other than Japan generally make products that have competing sources and therefore are not in a position to withhold technologies or parts and equipment from U.S. firms.

U.S. Firms' Experiences With Japanese Suppliers

Information obtained from 59 firms and two government research laboratories revealed the following:

- Fifty-two were purchasing state-of-the-art products from foreign suppliers. Nine said they were not purchasing foreign state-of-the-art products.
- Twenty-two provided specific examples of difficulties they had in obtaining parts, equipment, or technologies from Japanese suppliers that they said were being sold to other Japanese firms that were their competitors. Seven others said they experienced some difficulties, but did not provide specific examples.

[5]The report identified four products that were available in the United States at the time of the show. For the remainder of the 100 products described in the report, there is no mention as to whether they were available in the United States.

- Nineteen said they had no problems purchasing state-of-the-art Japanese products.
- Seven said they had experienced pressure from Japanese suppliers to take certain actions to obtain parts or equipment, but only one said it was a current problem (see chap. 4).[6]

Representatives from several of the companies that said they had no problems obtaining state-of-the-art Japanese products said they believed other U.S. firms did experience such problems. They had heard complaints from other companies or had seen products in Japan that were not available in the United States.

Examples of Difficulties Cited in Obtaining Japanese Products

Twenty-two companies and government research laboratories cited 59 specific instances of where they believe Japanese firms delayed selling or rejected their specific offers to buy items that they said were being sold to their Japanese competitors. Some of these companies or government laboratories cited only one instance of difficulty in obtaining parts and equipment from Japanese suppliers, while others cited several instances. The largest number of examples cited by an individual respondent was eight. Twelve of the 20 companies with specific examples are among the 500 largest U.S. firms, and 6 of these are among the 100 largest.

The examples cited by U.S. companies and government research labs occurred between 1977 and 1991. Only two of the examples noted occurred in the 1970s; the remainder were between 1983 and the present, with over 65 percent taking place between 1988 and 1991.

In 17 of the 59 examples cited, the U.S. firms said they experienced delays ranging from 6 months to 2 years in obtaining items they were seeking from Japanese suppliers. In several cases they asserted that by the time they had received the product it was a generation behind those that were available to Japanese companies other than the suppliers. In the other 42 cases the firms said they either never obtained the item from the Japanese supplier or were still waiting to obtain it. In about one-half of the 59 cases, the U.S. firms said there were either no alternative suppliers for the items they were seeking or no suppliers of items of comparable quality.

[6]Three of the seven firms said they had experienced both delays in obtaining items from Japanese suppliers and pressure to take certain actions to obtain items.

U.S. firms cited 37 different Japanese firms for declining to sell them products or for delaying their delivery by a period exceeding 6 months. The suppliers cited included both large and small Japanese firms. However, the suppliers cited most frequently (6 or more times) were large Japanese firms.

Most of the U.S. firms that cited instances of Japanese withholding said they knew the products they were seeking from Japanese suppliers were being sold to other Japanese companies. They had seen them in use at Japanese plants or had been told by Japanese companies with which they were doing business that they were being sold in Japan.

Products Cited as Having Been Withheld

U.S. company representatives provided (1) 43 examples of difficulties they said they had experienced in obtaining semiconductor manufacturing equipment and materials from Japanese firms; (2) 10 examples of problems in obtaining computer parts and components, including display screens and semiconductor chips; and (3) 6 examples of difficulties in obtaining other electronic items.

Table 2.1 shows the products that U.S. firms reported they had either been unable to obtain from Japanese suppliers or had experienced delays of over 6 months in obtaining. A glossary at the end of the report describes the various products.

Table 2.1: Products Cited by U.S. Firms as Being Difficult to Obtain From Japanese Suppliers

Product	Number of times cited
Semiconductor manufacturing equipment and materials	
Wafer fabrication equipment	
Steppers	8
Etching equipment	6
Ion implantation equipment	4
Other	8
Assembly equipment	4
Test equipment	3
Assembly and packaging materials	10
Subtotal	**43**
Computer parts and components	
Displays	4
Components for displays	3
Semiconductor chips	2
Peripherals	1
Subtotal	**10**
Other[a]	6
Total	**59**

[a]Includes electronic components other than semiconductors, and materials for electronic components.

Semiconductor Manufacturing Equipment and Materials

Some examples of difficulties in obtaining semiconductor manufacturing equipment and materials from Japanese suppliers reported by U.S. semiconductor and electronics firms are discussed below.

- One U.S. company official said his firm ordered an advanced stepper from a Japanese supplier in 1988 but did not receive it for 19 months. According to the company official, the supplier said it could not sell the stepper until it was adequately tested in Japan and until service facilities were established in the United States. The company official said that when he placed the order, a Japanese firm with which his company was involved in a joint venture had four of the same model stepper, which it had purchased from the same supplier earlier in 1988 without any delay. He said that by the time his company received the stepper, newer model steppers were already available in Japan.
- Representatives from a U.S. company said their firm ordered an advanced piece of etching equipment from a Japanese firm in April 1989 for which there were no U.S. suppliers. They said engineers from their firm had seen this equipment being used earlier that year at another Japanese firm with which it had a joint venture. The supplier reportedly told the firm that it could not sell the equipment because it was still

being test-marketed in Japan and because there was no service available in the United States and no manuals available in English. An engineer from the U.S. firm then attempted to tour the supplier's etcher factory in October 1989, but this request was denied. The U.S. company then reportedly was told by the supplier that the etcher it had been attempting to purchase was outdated and had been replaced by a newer, more advanced model. In March 1990, after 11 months of discussions with the supplier, the U.S. firm decided not to pursue trying to obtain the etcher.

- Representatives from a U.S. company said their firm attempted to purchase state-of-the-art track equipment (another type of wafer fabrication equipment) from a Japanese supplier in 1983, but did not obtain it for 18 months. The supplier reportedly attributed the delay to the time it took to provide servicing support for the equipment in the United States. The U.S. representatives said that by the time the company received the equipment, more advanced track equipment was available in Japan to Japanese firms. They noted that their firm currently experiences at least a 6- to 9- month delay in getting other semiconductor manufacturing equipment from this supplier.
- U.S. company official said his firm attempted to purchase a component made of high-purity carbon materials in April 1990 similar to those that a Japanese competitor had acquired from a Japanese supplier. When the U.S. firm tried to purchase the component from the same supplier, the supplier reportedly said there would be a 1-1/2 year delay in delivery because supplies were limited. As of late May 1991 the official said his U.S. company was still waiting to obtain this component. According to the official, the company's office in Japan verified that its Japanese competitor had acquired large quantities of the component in the past 6 months.

Computer Parts and Components

Some examples of problems in obtaining computer parts and components are described below.

- A U.S. company official said his firm tried to purchase state-of-the-art components for producing computer displays from a Japanese supplier in the fall of 1990. The supplier reportedly said that the components would not be available to the U.S. firm until 1992 because they were in short supply and the firm was supplying its Japanese customers first. The company official said that by the time his firm gets these components, newer ones will be on the market in Japan and will be in items produced by his Japanese competitors. As a result, he stated that his firm's products will be introduced on the market about 1 year after his

Japanese competitors' products. He said the only way his firm will be able to compete with his Japanese competitors is by reducing prices.

- A representative from another U.S. company said that in 1989 he attempted to purchase from two Japanese suppliers advanced display screens for computers his firm was trying to produce. He said he was told the suppliers were only selling these displays to Japanese companies. He then attempted to purchase samples of these displays but was told they would not be provided to American companies. He told us that these displays are only produced in Japan, so he has been unable to obtain them.

Other Products

An example of a U.S. firm's difficulty in obtaining other types of products from Japanese suppliers, including electronic components other than semiconductors and materials for electronic components, is discussed below.

- A U.S. company representative said his firm had to abandon plans for producing a fax machine in 1989 because it was unable to obtain a key component that is only produced in Japan. He said that his company went to four different Japanese suppliers to obtain thermal printheads - a type of electronic component that is a key component of a fax machine - which he maintained were being sold on the open market in Japan. He stated that he was unable to buy the components because he was quoted a price that was almost as high as the retail price of the entire fax machine.

Impact of Being Denied Technology

Many U.S. company representatives and industry analysts we interviewed stated that whether or not Japanese suppliers have legitimate reasons for delaying or declining sales of advanced parts or equipment is not important. In their view, the most important issue is the impact on U.S. competitiveness if U.S. high-tech firms are unable to obtain state-of-the-art parts and equipment that are only available in Japan. The analysts contended that if U.S. firms do not have access to sophisticated parts or equipment at the same time as their Japanese competitors, they will be at a distinct competitive disadvantage in designing and manufacturing next-generation products.

A semiconductor industry official discussed the significance of the delays faced by U.S. companies in gaining access to leading edge semiconductor manufacturing equipment, the majority of which he stated is now being produced in Japan. He said that leading edge U.S. semiconductor companies are now trying to purchase equipment to design and

produce products they will be introducing in 2 or 3 years; if they do not have access to leading edge equipment at the same time as their Japanese competitors, he maintained that they will "miss the window" for producing these products and be "one generation behind their Japanese competitors." In his view, even a 6-month delay in getting the latest equipment "will wipe out" a leading edge semiconductor company. The company would be late in bringing the next-generation semiconductor devices to market, and customers may not buy its devices if more sophisticated ones are available from Japanese suppliers.

Another company official pointed out that for products such as semiconductors with approximately 3-year life cycles, the first company or companies to come out with the next-generation product will reap the greatest benefits. They can charge the highest price for the product, whereas the price declines as additional suppliers enter the market.

Several government and industry studies have addressed the possible adverse impact that Japanese withholding of state-of-the-art technologies, parts, and equipment might have on U.S. firms.[7] Some of these studies also pointed out the vulnerability of U.S. firms that are dependent on Japanese competitors for key parts or components. Most of these studies echoed the views expressed by the industry analysts discussed above. They conclude that U.S. high-tech companies that are unable to obtain the latest and most advanced Japanese parts and equipment will lag behind their Japanese competitors in manufacturing next-generation products.

In discussing U.S. dependence on foreign semiconductor and semiconductor equipment suppliers, a 1987 federal interagency staff working group report[8] described the impact of U.S. firms not having timely access to Japanese technologies as follows:

> To the extent that downstream firms come to depend on Japanese or other foreign suppliers for semiconductors or semiconductor manufacturing equipment, they could be vulnerable [because] suppliers who are also competitors in the systems market could deliberately deny U.S. systems makers access to state-of-the-art semiconductors or semiconductor equipment. They do not need to do so for long. In many

[7]These studies include U.S. Supercomputer Vulnerability; Defense Semiconductor Dependency, Department of Defense, Office of the Under Secretary of Defense for Acquisition (Washington, D.C.: Feb. 1987); and The Semiconductor Industry, Federal Interagency Staff Working Group (Washington, D.C.: Nov. 16, 1987).

[8]The Semiconductor Industry.

of these industries, getting to market a few months or a year ahead of a competitor can represent a major competitive advantage.

Specific Examples of Impact

Representatives from 12 companies cited diverse types of impacts due to their inability to obtain advanced Japanese parts or equipment. Three companies, for example, provided estimates of lost sales, ranging from $20 million to $1.4 billion. Representatives from three other companies stated that they were unable to manufacture certain products because they could not obtain needed Japanese parts or components for which there were no alternative suppliers. Officials from two companies said they introduced new products about 1 year after their Japanese competitors because they encountered 9- to 15-month delays in obtaining necessary Japanese parts that were being sold to their Japanese competitors but not being produced outside Japan.

Many of the U.S. companies that cited the most adverse impacts from their firms' inability to obtain Japanese products were companies that said they had difficulty obtaining displays, components for displays, and other electronic components. Many companies that cited examples of difficulties obtaining Japanese semiconductor manufacturing equipment, by contrast, said that the impacts were difficult to quantify because they were often able to obtain the equipment from non-Japanese suppliers although it was usually of lesser quality.

Some examples cited by these companies of how Japanese withholding of advanced products has affected them are discussed below in greater detail.

- A representative from a small U.S. computer company said his firm lost about $65 million in orders in 1989 and is "essentially out of business" because the only displays it was able to obtain from Japanese suppliers were poor quality and not compatible with its laptops. According to this official, the firm had a contract with a Japanese supplier for certain types of displays that would be compatible with its laptops. However, he maintained that although the displays his firm received did not meet the specifications contained in the contract, the supplier refused to sell his firm higher quality displays. The official added that his firm was unable to purchase other types of state-of-the-art displays from two Japanese suppliers in 1989. He noted that advanced displays suitable for laptops are only produced in Japan.
- Another electronics company representative said his firm was unable to obtain components to produce display screens from a Japanese supplier

with which it had a joint venture in the mid-1980s. The supplier allegedly told the company that these screens could only be manufactured in Japan. As a result, the company had to purchase the finished displays from the Japanese company rather than producing them itself. According to this official, a major reason that the company decided to close its Japanese operations in the 1980s was that it faced difficulties in acquiring state-of-the-art Japanese products and technologies.

- Another U.S. electronics company official said that his firm is significantly behind its two Japanese competitors in sales and is increasingly losing market share to these companies because it can only obtain one-fourth of the state-of-the-art displays it needs from Japanese suppliers to produce a consumer electronics product. In addition, he maintained that his firm faces an 18-month delay in obtaining these displays and is charged more than Japanese competitors. He stated that he has been told by his firm's Japanese affiliate that Japanese competitors can get as many displays as they need in a 6-month period.
- A U.S. semiconductor company official who said his firm had difficulty obtaining state-of-the-art wafer steppers from a Japanese supplier stated that it produced 5-7 percent fewer semiconductors with an older generation stepper than it would have with a more sophisticated stepper. This difference in semiconductor production, he said, amounts to a total cost differential of 10-12 percent because of the greater cost in labor, equipment, and materials with lower production from each machine.

Representatives from these companies cited other problems as well. These problems included difficulty in planning to introduce new products and in determining the volume of production runs because of uncertainty about their ability to obtain adequate supplies of Japanese parts and components and/or equipment.

Representatives from several other companies spoke in more general terms about how their inability to acquire state-of-the-art Japanese products had affected their overall competitiveness. The adverse impacts they cited included lower semiconductor yields, higher manufacturing costs, the inability to perform certain manufacturing processes, and the production of lower quality or less reliable products. Several company officials said that because the life cycle for high-tech products such as semiconductors is so short, a delay of as little as 6 months in obtaining a state-of-the-art piece of equipment or a needed part or component can cause a company to be late in introducing a new product and thus to be noncompetitive.

Views on Whether U.S. Suppliers Withhold State-of-the-Art Products

One semiconductor industry analyst said that in the 1970s and early 1980s when U.S. firms were dominant in the semiconductor and semiconductor equipment industries, some U.S. suppliers gave preference to their U.S. customers in selling state-of-the-art products. However, most industry analysts and U.S. government officials we contacted stated that over the past few years U.S. high-tech firms have sold their latest products and technologies to companies regardless of their country of origin. They cited a variety of reasons for this practice. For example, many U.S. high-tech firms are small and financially weak and frequently must license technologies or sell products to "any company that can provide them with capital." In addition, the size of the U.S. market for semiconductors is currently smaller than the size of the Japanese market, so U.S. semiconductor and semiconductor equipment firms have to sell in Japan and other foreign countries to survive financially.

Some U.S. company officials and industry analysts reported that, rather than withholding state-of-the-art products from Japanese companies, some U.S. high-tech companies have recently introduced some of their new products first in Japan, primarily because of the increasingly large size of the Japanese semiconductor market and its growing importance for U.S. firms. For example, in 1990 some U.S. SM&E manufacturers introduced new products in Japan at a major semiconductor equipment trade show before they were introduced in the United States. In addition, in 1990 a large U.S. semiconductor company introduced one of its new semiconductor devices in Japan, and in 1991 a large U.S. computer company introduced a new model of its laptop in Japan before it did so in the United States.

U.S. Industry Views on Reducing U.S. Dependence on Foreign Suppliers

Representatives from many U.S. companies told us they believe Japanese suppliers favor domestic companies over foreign companies in selling their state-of-the-art products. However, most of these representatives did not believe that this practice was illegal. Further, even the company representatives that believe that Japanese suppliers are intentionally withholding state-of-the-art products did not advocate imposing punitive measures against these suppliers. Instead, they recommended strengthening the U.S.' high-tech manufacturing base and lessening U.S. dependence on Japan for critical technologies and parts and equipment.

Some industry representatives attributed the weakness of many U.S. semiconductor and computer firms to U.S. economic policies and decisions made by the firms themselves. They noted that some of these

firms have been reluctant to invest in long-term research and development efforts or to work with their suppliers to improve the quality of their products. Many industry officials also cited the high cost of capital in the United States and current U.S. tax and antitrust laws as major impediments to U.S. companies investing in the development of advanced technologies and products.

Various Reasons Cited for Lack of Prompt U.S. Access to Japanese Technology

U.S. company representatives told us that Japanese suppliers often cited reasons for delaying or denying sales, such as the need for product servicing and testing. Table 3.1 lists the reported reasons given by Japanese suppliers for their inability to sell products or for delayed sales.

Table 3.1: Reasons Given by Japanese Suppliers to U.S. Companies

Reason	Number of instances
No U.S. service facilities	12
Product still being tested	12
Product being supplied to Japanese customers first	6
Product not exported	6
No reason given	6
Manuals not available in English	5
Product in short supply	5
Sale prohibited by Japanese export control laws	2
Supplier unable to meet customer's specifications	1
Total	**55**

Note: In two instances, the reason given by the Japanese supplier was not specified. In two other instances, the U.S. company maintained that the price quoted by the supplier was prohibitive.

The six Japanese companies we interviewed denied most of these reasons and stated that their companies do not sell their state-of-the-art products to domestic firms before U.S. firms. MITI officials also denied that Japanese companies provide their state-of-the-art products to domestic firms before U.S. firms.

Most U.S. industry representatives we interviewed noted that they believe that other factors, such as the potential of a U.S. company to purchase large quantities of products and the presence of U.S. company facilities in Japan, enhance a company's ability to purchase leading edge Japanese products.

Lack of Service

According to the U.S. firms and government research laboratories that provided specific examples of problems in buying advanced Japanese products, a lack of U.S. service facilities was one of the most common reasons given by both large and small Japanese suppliers for delaying or denying sales of their state-of-the-art products. Most of these examples involved attempted purchases of very sophisticated semiconductor manufacturing equipment. According to these U.S. company representatives, Japanese suppliers frequently stated that they would not sell their advanced products to U.S. firms because the equipment could not be

adequately serviced in the United States. Some Japanese suppliers reportedly told U.S. companies that service for their new equipment would be available in the United States in the next 6 months to 2 years, while other suppliers said they did not know when their company would be able to service the equipment.

Some U.S. company representatives stated that a lack of service support in the United States would be a legitimate reason for delays in the sales of Japanese state-of-the-art products to U.S. firms. Because U.S. semiconductor companies are dispersed geographically throughout the United States, one U.S. company official noted the difficulty that small and medium-sized Japanese SM&E companies may face in establishing adequate U.S. service networks. Several U.S. company representatives agreed that small Japanese SM&E firms may not be able to afford to service their equipment in the United States.

Another U.S. company representative acknowledged that suppliers need a certain amount of time to establish service facilities for their new products in foreign countries. He noted that his company introduced a product in Japan 3 to 6 months after it was introduced in the United States. In addition, some U.S. and Japanese company officials pointed out that U.S. and Japanese companies generally have different approaches to servicing their equipment. They maintained that U.S. companies routinely establish service agreements with their suppliers, whereas service agreements are rare in Japan because suppliers usually train customers to operate and maintain their new equipment when it is being developed and tested.

Other U.S. companies, however, said that a lack of service support in the United States would not be a legitimate reason for delayed U.S. sales of Japanese products. They maintained that almost all large Japanese companies have established some kind of service facility in the United States and should be able to service their latest equipment. One company representative, for example, commented that although most U.S. SM&E companies are smaller than their Japanese counterparts, they have been able to establish foreign networks to provide adequate service support. According to this official, Japanese companies have purposely not made an effort to set up an extensive support network abroad. In his view, Japanese suppliers intentionally withhold advanced equipment from foreign semiconductor producers in order to keep innovative technologies in Japan.

Representatives from several of the U.S. industry associations we interviewed argued that Japanese suppliers could sell their latest products in the United States if they wanted to. One association representative, for example, maintained that some Japanese companies have made a deliberate decision not to establish a U.S. sales and service infrastructure.

Five of the six Japanese companies that we interviewed denied that a lack of U.S. service facilities would prevent sales of these products to U.S. firms. They emphasized that in almost every case, their companies are able to service their latest and most advanced equipment in the United States. An official from the other company, however, commented that his firm will not aggressively market products in the United States that it cannot adequately service. He explained that under certain conditions, such as if a product is potentially dangerous, his company would not sell it in an area where no qualified service was available. However, if the company is satisfied that the customer can get qualified service from other companies, it will consider selling its equipment in areas where it does not have its own service facilities.

Several Japanese company officials emphasized the importance their company places on reliable, quality products. They told us that they would not sell their semiconductors or equipment without service because sales and service go "hand in hand." However, these officials reiterated that they are able to service their most advanced equipment in the United States.

One Japanese representative noted that because of his firm's concern about the reliability of its products, it specifically trains engineers at its U.S. facilities to service the company's latest equipment. Another company official said that if a piece of its equipment in the United States needs repair, the company will "fly over engineers" to service it.

We also contacted the U.S. subsidiaries of 11 of the largest Japanese SM&E companies. Eight of these have service facilities in the United States. Representatives from these subsidiaries told us that their service divisions could service all the equipment sold by their company, including state-of-the-art equipment.

Although all but one of the Japanese companies we interviewed denied that a lack of U.S. service support would cause them to delay or deny sales of their most advanced products to U.S. firms, it should be noted that we did not interview small Japanese suppliers of semiconductor equipment. According to MITI officials, smaller Japanese SM&E companies

may have more difficulty than larger firms servicing their equipment in the United States and other foreign countries.

Product Testing

According to the companies we interviewed, the need for testing new products was another reason small and large Japanese suppliers commonly gave for delaying or denying sales of their latest technologies. These suppliers were primarily in the semiconductor and SM&E industries. In several cases, Japanese suppliers reportedly told U.S. firms that their state-of-the-art products were being tested or "debugged" and were not ready for sale. Several U.S. company representatives told us that Japanese suppliers often give certain domestic customers prototypes of their next-generation equipment or components to test for up to 2 years before selling them to foreign companies. They believed that this practice gives their Japanese competitors a substantial advantage in developing next-generation products.

The Japanese companies we interviewed denied that testing would cause delays in selling their advanced products to U.S. companies. In addition, MITI officials stated that Japanese companies do not favor domestic over foreign companies when choosing customers to test their new, state-of-the-art products.

Semiconductors

Representatives from the Japanese semiconductor companies we spoke with said they do not favor domestic companies when choosing which companies will test their next-generation semiconductor chips. They explained that they provide samples of chips to certain customers before they are sold commercially. They do so based on the customer's technical ability to test the samples and provide feedback to the supplier and its ability to buy the product once it is ready to be commercially sold. They explained, however, that the companies that are chosen to test their chips must have the financial resources to devote to testing; they must provide their own engineers and use their own equipment to do the testing. Because of this financial burden, they noted that most of the companies that do the testing are large firms. One Japanese company official noted that his firm recently supplied samples of 16-megabit DRAMs (which are not yet commercially available) to 10 U.S. companies, 4 European companies, and 1 Japanese company that is a subsidiary of a U.S. company.

Semiconductor Materials and Equipment

Officials from the Japanese SM&E companies that we interviewed also said they extensively test their products before selling them on the market. However, many U.S. company representatives we contacted maintained that Japanese companies test their equipment with other Japanese companies before selling the equipment commercially. Officials from the Japanese firms denied this assertion, maintaining that they generally only test their new equipment in-house.

One Japanese supplier said that it has never allowed other companies to test its equipment before selling it on the market. A representative from another Japanese company commented that his firm only tests its most advanced equipment used for research and development purposes with customers before making it commercially available. He identified only one product that his firm has allowed its customers to test in the development phase in the past few years. According to the supplier, this product was tested by four U.S. and five Japanese companies at their facilities before it was made commercially available. He explained that his company chooses test partners that have the technological capabilities to provide it with adequate feedback on the equipment's performance. He emphasized the high cost of maintaining the equipment and providing comprehensive technical feedback, and he noted that small companies might not have the financial or technical resources to adequately evaluate new equipment.

MITI stated that in surveying three large Japanese SM&E companies on their sales of lithography equipment to Japanese and U.S. firms, it found that these companies' new equipment was sold to an equal number of Japanese and U.S. companies within months after it had been introduced on the market.

Although some large U.S. companies with facilities in Japan have been given the opportunity to test Japanese equipment still in the development stage, most U.S. firms indicated that it is rare for a foreign customer to test next-generation Japanese equipment and parts. One industry association representative commented that "logistical problems," such as transporting heavy equipment overseas, prohibited Japanese companies from testing their products with U.S. companies at their U.S. facilities. He noted that testing in the United States could cost 2 to 3 times more than testing a new piece of equipment in Japan.

Product Supplied to Japanese Customer First

Many U.S. companies told us that Japanese companies supply their domestic customers before foreign firms. Representatives from two U.S. industry associations contended that Japanese suppliers purposely withhold their state-of-the-art parts and equipment from U.S. and other foreign firms to give Japanese firms a competitive edge. They discounted the reasons generally given by Japanese suppliers for declining to sell their latest products in the United States or for delaying sales.

One industry association representative said that although he believes that Japanese firms supply the Japanese market first, he does not believe that they intentionally "withhold" products from U.S. firms. He believes that supplying domestic firms first is a "standard business practice." Another representative from this association said that Japanese suppliers, particularly smaller ones, will generally sell their advanced equipment and parts in Japan first because it is "easier and cheaper" than selling them overseas.

The Japanese companies we interviewed denied that they favor their domestic customers over their foreign customers. One company, in fact, maintained that it had sold critical pieces of advanced wafer fabrication equipment to three U.S. companies in the late 1980s before selling any to domestic firms.

Product Not Exported

Several U.S. industry analysts told us that some Japanese suppliers, particularly smaller ones, have little reason to export to the United States, because the Japanese market for semiconductors and semiconductor manufacturing equipment is currently larger than the U.S. market. However, the Japanese companies that were cited most frequently by U.S. companies for withholding advanced products were larger Japanese companies that do export to the U.S. market. One U.S. industry official stated that Japanese withholding of state-of-the-art technologies may become more prevalent in the future as the Japanese semiconductor market increases in size and the U.S. market stagnates or declines.

One Japanese supplier, cited by several U.S. companies as withholding SM&E equipment, told us it did not sell certain state-of-the-art equipment in the United States during the mid-1980s because it received no orders for it from U.S. companies until the late 1980s.

A representative from another Japanese supplier noted that there may be particular products that his firm does not sell to U.S. firms because of

a lack of demand. He said, for example, that his firm does not sell a particular piece of semiconductor manufacturing equipment in the United States because U.S. firms "won't buy it."

Manuals Not Available

All of the Japanese companies we interviewed said that the translation of service manuals into English would not delay the sale of products to U.S. firms. One company noted that some of its service manuals are written in English before they are written in Japanese. Another company stated that its manuals are written simultaneously in English and Japanese.

Product in Short Supply

Some U.S. companies told us that when a leading edge product is in short supply, Japanese companies are given preference over U.S. and foreign firms. One Japanese supplier told us that short supplies of some pieces of sophisticated semiconductor manufacturing equipment often cause delays ranging from 6 months to 1 year in sales to both U.S. and Japanese firms from the time of the initial order until delivery. Another company representative stated that his firm considers the size of the order when setting priorities for the allocation of its products that are in short supply.

Export Control Laws

One U.S. company official cited two instances in which his firm tried to purchase Japanese state-of-the-art semiconductor manufacturing equipment. The supplier allegedly told the official that he was prohibited from selling this equipment because of Japanese export control policy regulations.

However, officials from MITI and the Ministry of Foreign Affairs stated unequivocally that Japanese export control laws should never impede Japanese sales to American companies and that no sale to U.S. companies has been delayed due to export control regulations. In addition, the one Japanese company that reportedly cited export controls as a reason for not selling products to a U.S. firm told us that Japanese export control regulations would never inhibit its sales of high-tech products to the United States.

Supplier Unable to Meet Customer's Specifications

Two Japanese suppliers noted that they frequently tailor or customize products to meet customer specifications. This requirement often delays delivery by 6 months to 1 year from the initial order date. One company, for example, told us that its engineers had to spend 2 years customizing a sophisticated piece of semiconductor manufacturing equipment for a U.S. company. This supplier noted that it often receives requests for equipment that is more sophisticated than the model they have in stock and that they must make extensive modifications to the equipment. In addition, he stated that in the past few years his firm has received several inquiries from U.S. firms about equipment that it was unable to produce because the specifications were too sophisticated for the company's technological capabilities. He emphasized that the only criterion for selling its equipment to foreign customers is whether his company can build the equipment to the customer's technical specifications.

Other Factors Cited by U.S. Firms

Many U.S. industry representatives told us that some U.S. firms are in a better position than others to get the latest equipment and parts from Japanese suppliers. Factors that appear to affect a company's ability to obtain the latest and most advanced products from Japanese suppliers include the extent of its financial resources, the presence of any facilities in Japan, and the relationship it has established with Japanese suppliers.

U.S. Companies With Large Financial Resources

Many U.S. industry officials commented that U.S. companies that are able to buy semiconductors and semiconductor equipment in large volume can often purchase the latest and most advanced products before smaller companies with fewer financial resources. According to several U.S. company representatives, start-up companies are disadvantaged in trying to obtain leading edge Japanese products because they cannot place large orders and therefore do not have the "clout to get what they want." A few U.S. company representatives commented that Japanese firms supply their largest customers first, whether they are Japanese or American.

Despite this alleged advantage, almost one-half of the companies that told us they had withholding problems were large (Fortune 500) U.S. companies that generally buy Japanese products in large volume. An industry association representative told us that almost one-half of the 15 companies that voiced similar complaints to his association over the past several years have been large U.S. firms.

U.S. Companies With Facilities in Japan

U.S. firms that have some kind of facility in Japan, such as a manufacturing plant or a sales subsidiary, appear to be in a much better position to get the latest equipment than those without any presence there.

One industry analyst noted that unlike U.S. companies, Japanese companies generally have a "lifetime relationship and a real partnership" with each of their suppliers. Several company representatives explained that U.S. firms frequently switch suppliers and rarely try to cultivate long-term relationships. They noted that U.S. suppliers rarely work together with their customers in testing their products. The close Japanese customer/supplier relationship, by contrast, encourages the testing of new products among Japanese companies.

Several U.S. company officials stated that their presence in Japan has been crucial to establishing strong relationships with their Japanese suppliers. U.S. company representatives emphasized the importance that Japanese suppliers place on stable, long-term customer/supplier relationships. They noted that foreign firms that have made an effort to establish long-term relationships with Japanese suppliers are often better able to get the first allocations of the latest state-of-the-art products and are in a position to know about new Japanese technologies and products. One U.S. industry association representative stated that firms with no facilities in Japan face a delay of about 9 months in getting access to advanced Japanese semiconductors. A U.S. company representative also noted that companies without facilities in Japan will not be in a position to test Japanese chips or equipment. Further, a U.S. semiconductor association official pointed out that it is "easier and cheaper" to sell Japanese semiconductor equipment to U.S. companies located in Japan. This is especially true for smaller Japanese suppliers that do not have the resources for initiating foreign sales and marketing efforts and for establishing service facilities overseas.

One representative from a large Japanese company remarked that it does consider the "length" of the relationship with a customer, along with other factors such as the size of the order, when determining which customers receive the first allocations of its latest equipment. However, officials from a few other Japanese companies denied that the length of the relationship they have with a company is a factor in choosing which customers will test their products or receive the first allocations of their new products.

Most U.S. Companies Did Not Experience Pressure From Japanese Suppliers

Only seven of the 61 U.S. high technology firms and government research laboratories we interviewed told us that they were pressured by Japanese suppliers to take certain actions in order to obtain semiconductors. The practice of pressuring companies to buy certain products or to license their technologies in order to get an item they want is known as "tying" or "leveraging."

Six of the seven instances reported by U.S firms occurred in 1987 and 1988 during the DRAM shortage.[1] In our interviews with U.S. companies, Japanese companies were the only foreign suppliers cited as exerting pressure to take certain actions as a condition to obtain products. Several U.S. company representatives said that during the DRAM shortage, they were also subjected to tying arrangements by U.S. semiconductor firms. They noted that these types of arrangements are not uncommon business practices.

Only one U.S. company we spoke with said it had been subjected to leveraging pressure from a Japanese supplier in the past year. Many of the companies we contacted said they did not believe leveraging by Japanese suppliers was currently a problem.

Examples of Japanese Tying Practices Cited by U.S. Companies

Representatives from six of the companies we interviewed stated that they were pressured by Japanese companies to buy an array of semiconductor chips, such as logic chips or certain customized chips, in order to get adequate supplies of memory chips. Representatives from one of these companies said their firm was also pressured to license a technology in order to get adequate supplies of DRAMs. Officials from another company said that they were told that in order to buy a customized chip, they would also have to purchase telephone circuitry. Examples of these tying practices are discussed in more detail below.

- A representative from a U.S. telecommunications company told us that in 1990 he tried to purchase customized semiconductor chips to use in a telephone device. The company wanted to sell the device to the Japanese public telephone company, and the chip was necessary in order to make the telephone device compatible with the Japanese system. According to this company representative, the Japanese supplier stated

[1] Many industry experts believe that the DRAM shortage, which began in 1987, was initially due to a delay in U.S. companies' coming on line with the latest generation of memory chips, unprecedented demand, and restrictions imposed by the 1986 U.S.-Japan Semiconductor Trade Arrangement. The shortage ended in 1989, primarily because the computer industry took a downturn, demand decreased, and South Korean producers came on line with 1-megabit DRAMs.

that his company would not sell the chip unless the U.S. company also bought the entire surrounding circuit. The U.S. company official explained that his company already produced the surrounding circuit and only needed the chip. As of March 1991, he said his company was still trying to buy the chip.

- An official from a U.S. semiconductor company told us that in 1988 his company was pressured to buy specialized semiconductor chips in order to get DRAMs. This official stated that his company was not interested in buying the specialized chips since it also produces these chips. He stated that his company's chips were "superior in quality" but that it agreed to buy the chips from the Japanese supplier because it needed the DRAMs. He also commented that his company was "particularly hurt" during the DRAM shortage because it had not established a long-term relationship with its Japanese suppliers.
- During the DRAM shortage, one U.S. computer company representative said his firm had experienced pressure to buy customized chips. It also was pressured to make an advance commitment to purchase a certain amount of chips over a specific time period in order to get DRAMs. According to this representative, his company was eventually able to get the chips without buying the customized chips. However, it did have to agree to buy a specific quantity of chips during 1988 and 1989. He commented that he believes his company had problems with its Japanese supplier because it had no prior relationship with the company. This representative also stated that U.S. companies that had purchased products from Japanese suppliers for a long period of time were in a better position during the shortage.

U.S. Industry Association Views

Several officials from one industry association we spoke with stated they knew of several instances during the DRAM shortage in which Japanese companies had engaged in tying practices. However, none of the five industry associations and market research firms we interviewed knew of any recent complaints by U.S. companies about Japanese tying practices. One association representative specifically stated that he does not believe "tying" by Japanese suppliers is a problem, while another association official commented that leveraging by Japanese suppliers will become more prevalent in the future as Japan becomes more dominant in high-tech industries and advanced technologies.

U.S. Government Officials' Views

Officials from several U.S. government agencies told us that Japanese companies were engaged in tying practices between 1987 and 1989. One agency official stated that his office brought up the issue of tying 9 to

10 times during consultations with the Japanese government and asked the government to encourage Japanese companies to discontinue these practices. This official confirmed that U.S. companies licensed technologies to Japanese companies in order to get memory chips. A former U.S. government official told us that he knew of intelligence reports citing American company complaints that they could only get DRAMs from Japanese suppliers if the U.S. company licensed its technologies to the Japanese supplier. Another representative, who worked for a U.S. company during the DRAM shortage, stated that he had "firsthand" knowledge that Japanese companies told their U.S. customers that they could increase their allocations of DRAMs if they agreed to buy logic or other customized chips.

Types of U.S. Companies Interviewed, by Category

Computer/computer peripherals	15
Semiconductor	15
Semiconductor equipment	15
Semiconductor materials	3
Electronics	8
Telecommunications	2
Other	1
Total	**59**

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Glossary

Deposition	An operation in which a film is placed on a silicon wafer without a chemical reaction with the underlying layer.
Die Bonder	Assembly equipment that bonds the back side of an integrated circuit die to various materials. A die is a small piece of silicon wafer that contains the complete circuit being manufactured.
Dynamic Random Access Memory (DRAM)	The most common type of computer memory. DRAM architecture usually uses one transistor and a capacitor to represent a bit, which is a memory cell in a computer.
Emitter-Coupled Logic (ECL)	A type of microelectronic circuit design that is noted for its extremely fast switching speeds.
Electron Cyclotron Resonance (ECR)	A technology that uses a high-frequency microwave energy source to create a plasma in a confined region using a magnetic field for the purpose of etching and deposition.
Etching	A process in which acid is used to remove previously defined portions of the silicon oxide layer covering the wafer to expose the silicon underneath.
Flat Panel Displays	A thin display screen that uses any of a number of technologies, such as liquid crystal display. Flat panel displays are used in laptop computers in order to keep the overall size and weight of the machine to a minimum. In time, flat panel displays will supersede the cathode ray tubes that are widely used today in computers and televisions.
Gallium Arsenide	A compound semiconductor material that allows transistors and integrated circuits to operate much more rapidly than similar devices made of silicon.

Ion Implantation	A process in which silicon is bombarded with high-voltage ions in order to implant them in specific locations and provide the appropriate electronic characteristics.
Liquid Crystal Display (LCD)	A liquid crystal display is a technique that uses a transistor for each monochrome or each red, green, and blue dot. It provides sharp contrast and speeds screen refresh. LCD technology is commonly used in digital watches and laptop computers.
Lithography	A process in which the desired circuit pattern is projected onto a photoresist coating covering a silicon wafer. When developed, portions of the resist can be selectively removed with a solvent, exposing parts of the wafer for etching and diffusion.
Parallel Processor	A parallel processor is a computer in which a number of computations are carried out simultaneously on more than one central processing unit.
Peripheral	A peripheral is a device connected to a computer, such as a terminal or a disk drive.
Semiconductors (or Chips)	A material, typically silicon or germanium, that has four electrons in its outer ring and is a poor conductor of electricity. The term has come to refer to all devices made of semiconducting material, including transistors and diodes.
Silicon	One of the most common elements found in nature and the basic material used to make the majority of semiconductor wafers.
State-of-the-Art	State-of-the-art is the most current technique or method applied to designing and developing hardware and software.
Stepper	A sophisticated piece of equipment used to transfer an integrated circuit pattern from a mask onto a wafer.

Wafer	A thin disk, cut from silicon or other semiconductor material. The wafer is the base material on which integrated circuits are fabricated.